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TWO NEW TROGLOBITIC CRAYFISHES (DECAPODA,
ASTACIDAE) FROM FLORIDA

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The two species described here from Jefferson, Leon, and Wakulla Counties, Florida, bring the total number of troglobitic crayfishes recorded from the State to nine, all except one (*Cambarus cryptodytes* Hobbs, 1941: 110) of which are endemic. A key for the identification of the previously known species, together with brief summaries of their ranges, is presented by Hobbs (in press).

Juvenile specimens of one of the new species, *Procambarus orcinus*, were collected in 1956 by Horst R. H. Heinemann and were tentatively assigned by Hobbs (1958: 81) to *Procambarus pallidus* (Hobbs, 1940: 394). Some 3 years later, Warren (1961: 8) recorded the occurrence of *P. pallidus* in Clay Sink (almost certainly the same locality herein referred to as Gopher Sink), indicating that "The Leon Co. locality, though far removed from other known populations of *pallidus*, is not too surprising. Various limestone formations are at the surface along the coast from Leon Co. southward." Warren's record is based on the specimens collected by Heinemann.

More recently, Lawrence A. Abele donated three specimens of this species from Osgood Sink, Leon County to the Smithsonian Institution. Unfortunately, we have no record of the donor of the specimen collected from Wakulla Springs by L. B. Trott; however, the remaining material of *P. orcinus* was collected by Joseph Halusky and the junior author.

If the tentatively identified juvenile male of *Procambarus horsti*, the other species described herein, proves to be a valid

determination, it is the first known specimen of this species. It was collected from a well in Leon County and was sent to the Smithsonian by Stephen P. Cobb of the Florida Department of Natural Resources. Michael N. Horst presented us with the specimens comprising the type-series obtained from Big Blue Springs in Jefferson County.

We should like to thank all of those individuals who have donated or assisted in collecting the specimens on which this report is based. We are also grateful to Fenner A. Chace, Jr., Martha R. Cooper, and Marian H. Pettibone for their criticisms of the manuscript.

Procambarus orcinus new species

Figure 1

Procambarus pallidus (Hobbs, 1958: 81) [part].—Hobbs and Hart, 1959: 149.—Warren, 1961: 8 [part].—Hobbs, in press [part].

Diagnosis: Integument translucent, underlying tissues usually pinkish orange; eyes moderately large for troglobitic species, usually with small red pigment spot, but always lacking facets. Rostrum with marginal spines. Areola 31.2 to 35.6 percent of entire length of carapace and 8.9 to 11.8 times longer than wide. Two to 12 cervical spines present. Suborbital angle rudimentary. Postorbital ridge with apical spine and with 2 to 5 caudally situated ones. Hepatic area of carapace with few to many spines in adults, reduced in juveniles. Antennal scale approximately 2.2 times longer than wide, broadest slightly proximal to mid-length. Ischia of third and fourth pereopods of male with simple hooks, their tips over-reaching basioischial articulation. First pleopods slightly asymmetrical, with distinct rounded hump on cephalic surface, provided with subterminal setae, and reaching cephalad to coxae of third pereopods; distal extremity bearing (1) subspiculiform mesial process directed caudodistally, (2) prominent, laterally flattened, corneous cephalic process lying lateral to base of central projection and directed caudodistally, (3) corneous, beaklike central projection directed caudolaterally at right angle to principal shaft of appendage, and (4) caudal element consisting of two parts: small caudal knob lying at caudolateral base of central projection, and prominent, mesially inflated adventitious process located mesial to central projection, latter process with narrow, low, corneous, crestlike caudal margin. Annulus ventralis sculptured by only two conspicuous grooves: submedian, broadly sigmoid sinus, and subparallel shallow sulcus dextral to sinus. Sternum immediately cephalic to annulus with prominent, weakly bilobed, paired tubercles extending caudally from caudal margin.

Holotypic Male, Form I: Body (Fig. 1a, h) subcylindrical. Abdomen narrower than thorax (7.5 and 8.5 mm). Greatest width of carapace

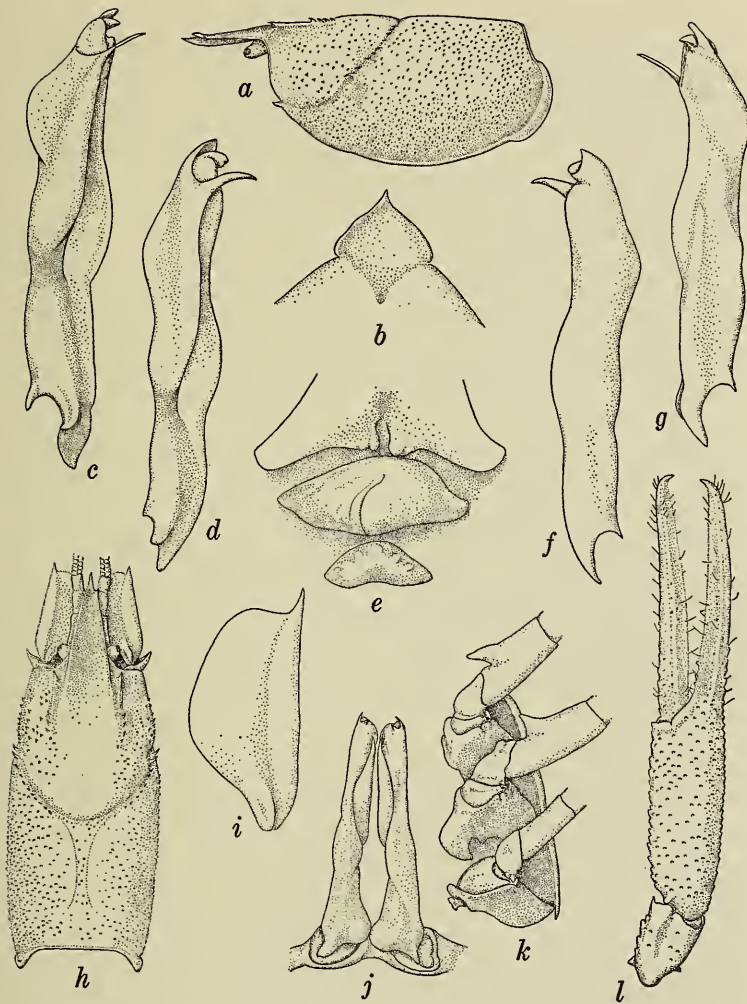


FIG. 1. *Procambarus orcinus* new species. a, Lateral view of carapace of holotype; b, Epistome of paratypic male, form I; c, Mesial view of first pleopod of holotype; d, Mesial view of first pleopod of morphotype; e, Annulus ventralis of allotype; f, Lateral view of first pleopod of morphotype; g, Lateral view of first pleopod of holotype; h, Dorsal view of carapace of holotype; i, Antennal scale of holotype; j, Caudal view of first pleopods of holotype; k, Basal podomeres of third, fourth, and fifth pereopods of holotype; l, Dorsal view of distal podomeres of cheliped of holotype.

subequal to height at caudodorsal margin of cervical groove (8.5 and 8.6 mm). Areola 10.2 times longer than wide with 2 punctations across narrowest part. Cephalic section of carapace almost twice as long as areola (length 34.8 percent of entire length of carapace). Rostrum excavate dorsally with unthickened, strongly convergent margins; marginal spines long and acute, distinctly delimiting, although asymmetrically, base of acumen, latter reaching level of distal end of peduncle of antennule; dorsal surface with deepest concavity at level slightly anterior to caudal margin of orbit, with submarginal row of setiferous punctations and scattered ones between. Subrostral ridges weak and evident in dorsal aspect only in caudal orbital region. Postorbital ridges very prominent, strongly elevated cephalically, and bearing 3 cephalically inclined spines basally and slender acute spine at apex; dorso-lateral groove scarcely evident. Suborbital angle obsolete. Branchiostegal spine prominent. Dorsomedian and extreme cephalolateral portions of carapace punctate; hepatic region with group of prominent spines laterally and dorsolaterally; branchiostegites tuberculate, with row of 11 spines on left side and 9 on right immediately caudal to cervical groove, all in series with usual cervical spines; row continuing cephaloventrally as tubercles to base of branchiostegal spine.

Abdomen longer than carapace (22.4 and 20.7 mm). Cephalic section of telson with 2 spines in each caudolateral corner. Cephalic portion of epistome subtriangular, more rounded than in Figure 1b, with prominent cephalomedian projection; lateral margins only slightly elevated (ventrally) above surface; fovea well developed. Antennules of usual form with very prominent, anterolaterally directed spine on ventral surface of basal article of peduncle near midlength. Antennae extending considerably beyond caudal margin of telson. Antennal scale (Fig. 1i) 2.2 times longer than wide, greatest width slightly proximal to midlength, with lamellar area distinctly broader than thickened lateral part; latter terminating in moderately long spine.

Third maxilliped extending anteriorly to level of tip of rostrum; opposable margin of ischium with teeth, its ventrolateral surface devoid of setae.

Right chela (Fig. 1l) slender and elongate, subovate in cross section, not strongly depressed. Mesial surface of palm with several rows of 9 or 10 tubercles; lateral margin of palm with serrations extending along proximal third of fixed finger; dorsal and ventral surfaces entirely tuberculate. Both fingers provided with submedian longitudinal ridges dorsally and ventrally; dorsal ridges flanked proximally by tubercles and setiferous punctations along distal four-fifths. Opposable margin of fixed finger with 3 small corneous tubercles along proximal fourth, and similar large acute tubercle present at lower level slightly proximal to midlength; minute denticles present along entire length of finger. Opposable margin of dactyl studded with minute denticles, lacking teeth; mesial margin of dactyl tuberculate along proximal half, tubercles decreasing in size distally, and punctate along distal half.

Carpus of right cheliped longer than broad (3.9 and 2.5 mm) with all surfaces sparsely tuberculate; dorsal surface with only slight depression representing usual oblique longitudinal groove; dorsomesial margin with row of 4 tubercles and prominent spine on dorsomesial distal angle; ventrodistal margin with 2 spines, 1 at base of ventrolateral condyle, other more mesial in position.

Merus of right cheliped tuberculate except proximomesially, there sparsely punctate; upper surface with 4 spiniform tubercles, 3 of these forming subdistal group; ventral surface with lateral row of 14 tubercles of which eighth, tenth, twelfth and fourteenth from base large and spikelike, and mesial row of 20 of which only distalmost spikelike; other tubercles flanking 2 rows and crowded between them; ventral laterodistal angle also with strong spiniform tubercle. Ischium with 3 small tubercles dorsally, punctate laterally and mesially, and with row of 6 tubercles ventrally. Basis with 2 small tubercles ventrally, otherwise punctate.

Hooks on ischia of third and fourth pereopods (Fig. 1k) simple and over-reaching basioischial articulation; basis of fourth pereopod with prominent tubercle opposing hook. Coxa of fourth pereopod with massive boss; that of fifth pereopod with smaller cephalocaudally flattened prominence extending ventrally from caudomesial ventral angle.

Sternum between second, third, and fourth pereopods only moderately deep, bearing fringe of setae on ventrolateral margins.

First pleopods (Fig. 1c, g, j) as described in diagnosis. Subterminal setae projecting caudodistally from immediately caudolateral to caudal knob around lateral base of cephalic process, and almost to base of mesial process.

Uropod with 2 distally projecting spines on basal podomere; median spine on mesial ramus not reaching distal margin of ramus.

Allotypic Female: Differs from holotype in following respects: acumen reaching slightly beyond level of distal end of antennular peduncle; cervical groove flanked caudally by row of 10 spines on each side; third maxillipeds extending anteriorly to level of penultimate article of peduncle of antennule; lateral margin of chela weakly serrate; opposable margin of fixed finger with row of 6 small, corneous tubercles along proximal two-fifths with larger one at lower level slightly proximal to midlength; opposable margin of dactyl with row of 12 minute corneous tubercles along proximal half; upper surface of merus with 7 spiniform tubercles, 4 grouped subdistally, ventral surface with mesial row of 17 tubercles (most along distal half spiniform) and lateral row of 16; tubercles on ischium and basis of cheliped much reduced. See Table 1.

First pleopods uniramus and small but extending cephalad to cephalic margin of annulus. Sternum cephalic to annulus (Fig. 1e) very shallow with conspicuous caudomedian longitudinal groove flanked by paired tuberculiform prominences extending caudoventrally from caudal margin. Annulus ventralis subovate, broader than long, with median portion

Table 1. Measurements (mm) of *Procambarus orcinus*.

	Holotype	Allotype	Morphotype
Carapace:			
Height	8.6	9.3	8.5
Width	8.5	9.5	8.7
Length	20.7	22.4	21.0
Areola:			
Width	0.7	0.7	0.6
Length	7.2	7.5	7.1
Rostrum:			
Width	2.5	2.8	2.5
Length	6.0	6.9	6.1
Chela:			
Length of inner margin of palm	6.8	5.2	4.5
Width of palm	3.0	2.5	1.9
Length of outer margin of chela	17.6	14.1	10.9
Length of dactyl	10.1	8.6	5.8

gently elevated and bearing submedian longitudinal sinus, latter originating slightly cephalic to midlength, forming broad dextral arc and cutting caudal margin slightly dextral to median line. Sternal plate between fifth pereopods concave caudally, somewhat depressed in caudomedian area and with cephalic arc of 6 tubercles.

Morphotypic Male, Form II: Differing from holotype in following respects: acumen extending distinctly beyond level of distal end of antennular peduncle; cervical groove flanked caudally by row of 9 spines on left and 11 on right; 4 posterior spines on posterior part of left postorbital ridge and 2 on right; third maxillipeds reaching distal end of antennular peduncle; lateral margin of chela very weakly serrate; opposable margin of fixed finger with moderately large corneous tubercle at end of proximal tenth of finger and very large one at lower level near end of basal third; opposable margin of dactyl with 5 very small corneous teeth along basal third; dorsomesial surface of carpus with only 2 tubercles; dorsal surface of merus with row of 16, mostly spiniform, tubercles, ventral surface with lateral row of 13 tubercles and mesial one of 12, only distalmost as prominent as largest 3 in lateral row; ischium with dorsal tubercles almost obsolete and with 7 small ones ventrally; tubercles on basis almost atrophied; hooks on ischia of third and fourth pereopods reduced to tubercles; boss on coxa of fourth pereopod reduced, and prominence on fifth represented by small tubercle. See Table 1.

First pleopod (Fig. 1d, f) differing chiefly from that of holotype in lacking corneous elements, mesial process comparatively more robust, cephalic process forming broad subacute hood extending over cephalolateral portion of rounded central projection, and caudal element exceedingly reduced.

Type-locality: Gopher Sink, 3.1 miles southwest of Florida Road 61 and 0.2 miles east of Florida Road 369 (SW $\frac{1}{4}$, NW $\frac{1}{4}$, NE $\frac{1}{4}$ Sec. 16, T. 2S, R. 1W), Leon County, Florida. The type-locality is a limestone sinkhole in the Woodville Karst Plain (Hendry and Sproul, 1966: 29). It is steep-sided, nearly vertical in some parts, with walls about 35 feet from ground level to the water line. The underwater portion of the sinkhole has a greater diameter (about 100 feet) near the floor than at the surface (about 75 feet). Beginning at about 55 feet below the surface, an underwater cavern opens to the east and extends for about 300 feet, sloping downward to a water-pressure depth of about 100 feet (L. Briel, personal communication). The cavern is approximately 20 feet high by 40 feet wide at its mouth and does not taper appreciably until about 120 feet from the entrance. In the colder months, from November through April, the water is clear with nearly unlimited visibility. Measured water temperature at 65 feet depth was constant at 22°C between 3 February and 11 March 1971. The surface temperature varied slightly, depending upon the air temperature. The floor of the cavern was covered by deep silt which billowed up in a dense cloud with the slightest disturbance.

Types: The holotypic male, form I, allotypic female, and morphotypic male, form II, (Nos. 132031, 132032, 132033, respectively) are deposited together with the paratypes (2 ♂ I, 3 ♂ II, 10 ♀, 3 ♂, 3 ♀, all from the type-locality) in the National Museum of Natural History, Smithsonian Institution. Two of these specimens were collected by Heinemann and the others by Halusky and the junior author.

Size: The largest first form male has a carapace length of 21.4 mm, the smallest 19.3 mm. The largest female has a comparable length of 23.9 mm, and the largest specimen, a second form male, 25.3 mm.

Range and Specimens Examined: *Procambarus orcinus* is known from only four localities in Leon and Wakulla counties, Florida: (1) type-locality; (2) Osgood Sink (NE $\frac{1}{4}$ Sec. 11, T. 2S, R. 1E), Leon County, 1 ♀, 1 juv. ♂, 1 juv. ♀, 2 Sept. 1968, James Bishop, coll.; (3) Culley's Cave, 0.2 miles east of Florida Road 369 and 0.4 mile north of Leon-Wakulla County line (SE $\frac{1}{4}$ Sec. 17, T. 2S, R. 1W), Leon County, 1 juv. ♂, 1 juv. ♀, 25 March 1971, Joseph Halusky, coll.; 1 juv. ♂, 1 juv. ♀, 29 April 1971, D. B. Means and J. Halusky, coll.; and (4) Wakulla Springs, Sec. 11, T. 3S, R. 1W, Wakulla County, 1 juv. ♂, 4 May 1957, L. B. Trott, coll.

Variations: There seems to be an almost direct correlation between the size of the individual and the relative development of spines and tubercles on the carapace: the larger the individual the more tubercles and spines. There is also a suggestion that allometric growth occurs

between the length of the areola and that of the cephalic region of the carapace: with increase in carapace length there seems to be a proportionately greater increase in the length of the areola.

Except as indicated above, the range of variation among our specimens from the type-locality is, for the most part, no greater than that described for the primary types. The juvenile female obtained by Heinemann is somewhat exceptional in having an areola that comprises 36.2 percent of the carapace length.

The three specimens from Osgood Sink are typical in every respect, and possess areolae ranging from 31.4 to 35.2 percent of the entire length of the carapace.

The single juvenile male from Wakulla Springs, having a carapace length of 11 mm, has a smooth carapace, lacking hepatic spines; only a single large cervical tubercle is present on each side, and the post-orbital ridges lack the caudal spines. It does not differ markedly, however, from juvenile specimens from the type-locality.

The four specimens from Culley's Cave (two with complete rostra have carapace lengths of 12.1 and 16.2 mm) are without pigment, lack the red eye-spot typical of individuals from Gopher Sink, and have spines on the carapace distinctly less well-developed than in the adult specimens from the latter mentioned locality. Except for the lack of pigment, however, they are not conspicuously different from the smaller members of the type-series.

It should be pointed out that pigmentation, which disappears soon after preservation, of specimens from Osgood Sink, Wakulla Springs, and those collected from "Clay Sink" by Heinemann, was not recorded on the labels accompanying them.

Life History and Ecological Notes: First form males were collected on February 26 and April 3. No ovigerous females have been observed, although a copulating pair was seen at the type-locality on 3 April 1971.

Specimens were obtained by the junior author in November, February, and March. They were found clinging upside-down to the ceiling and head down on the vertical sidewalls. The first individuals seen were about 25 feet from the mouth of the cavern, and sightings became more frequent with increasing penetration to about 150 feet, beyond which no collections were made, although crayfish were observed deeper in the cavern. Light was just perceivable 150 feet from the mouth, indicating that these animals are abundant in the twilight zone. Individuals were most numerous along the walls, especially where there were cracks and fissures near the floor. When disturbed, they swam toward the bottom. If pursued, the majority came to rest partially buried in the bottom sediments. The pinkish-orange color of many individuals was obvious at the time of collection; however, some were white. All specimens were observed to have pigmented eyes while alive, but the color disappeared a short time after preservation. The pigmented crayfish emitted an orange-colored fluid from their mouths when placed in formalin. A few unidentified troglotic isopods were

observed on the limestone in the cavern. These also had a pinkish-orange color. On one occasion, an isopod was apparently eaten by a crayfish within 10 minutes after being brought to the surface. Dead and injured crayfish were usually cannibalized if not removed from containers shortly after arrival at the surface. Animal life found in the lighted water of the sinkhole included *Palaemonetes paludosus* (shrimp), *Anguilla rostrata* (American Eel), *Hybopsis harperi* (Florida Chub), and *Gambusia affinis* (Mosquitofish). All of these except the Mosquitofish were seen at least once in the twilight zone of the cavern.

Relationships: See discussion of relationships for *P. horsti* below.

Etymology: *Orcinus* (L., of the nether world), referring to the spelean habitat of this crayfish.

***Procambarus horsti* new species**

Figure 2

Diagnosis: Body white or colorless, eyes small, lacking pigment and facets. Rostrum with marginal spines. Areola 40.2 to 41.8 percent of entire length of carapace, and 13 to 19 times longer than wide. Ten to 12 cervical spines present. Suborbital angle rudimentary. Post-orbital ridges with paired apical spines and 2 or 3 caudally-situated spiniform tubercles. Hepatic area of carapace with many spines. Antennal scale approximately 2.1 times longer than wide, broadest short distance proximal to midlength. Ischia of third and fourth pereopods with simple hooks, tips extending proximally over corresponding bases. First pleopods asymmetrical, reaching cephalad to coxae of third pereopods, lacking distinct shoulder on cephalic surface, but provided with subterminal setae; distal extremity bearing (1) subspiculiform mesial process directed caudodistally, (2) prominent, laterally flattened, corneous cephalic process lying lateral to base of central projection and inclined caudodistad but with tip directed caudad, (3) corneous, beaklike central projection directed caudomesially at right angle to principal shaft of appendage, and (4) caudal element consisting of 2 parts: vestigial caudal knob lying at caudolateral base of central projection and prominent, mesially inflated adventitious process situated mesial to central projection, latter process with narrow, low, corneous, crestlike caudal margin. Annulus ventralis sculptured by 2 moderately conspicuous grooves: submedian, slightly undulating sinus, and subparallel shallow sulcus sinistral to sinus. Sternum immediately cephalic to annulus multi-tuberculate, with 1 or 2 tubercles on each side of median line slightly overhanging (ventrally) cephalic margin of annulus when latter pressed forward.

Holotypic Male, Form I: Body (Fig. 2a, h) subcylindrical. Abdomen narrower than thorax (12.3 and 17.6 mm). Greatest width of carapace greater than height at caudodorsal margin of cervical groove (17.6 and 14.1 mm). Areola 15.9 times longer than wide with 2 or 3 punctations across narrowest part. Cephalic section of carapace about 1.4 times

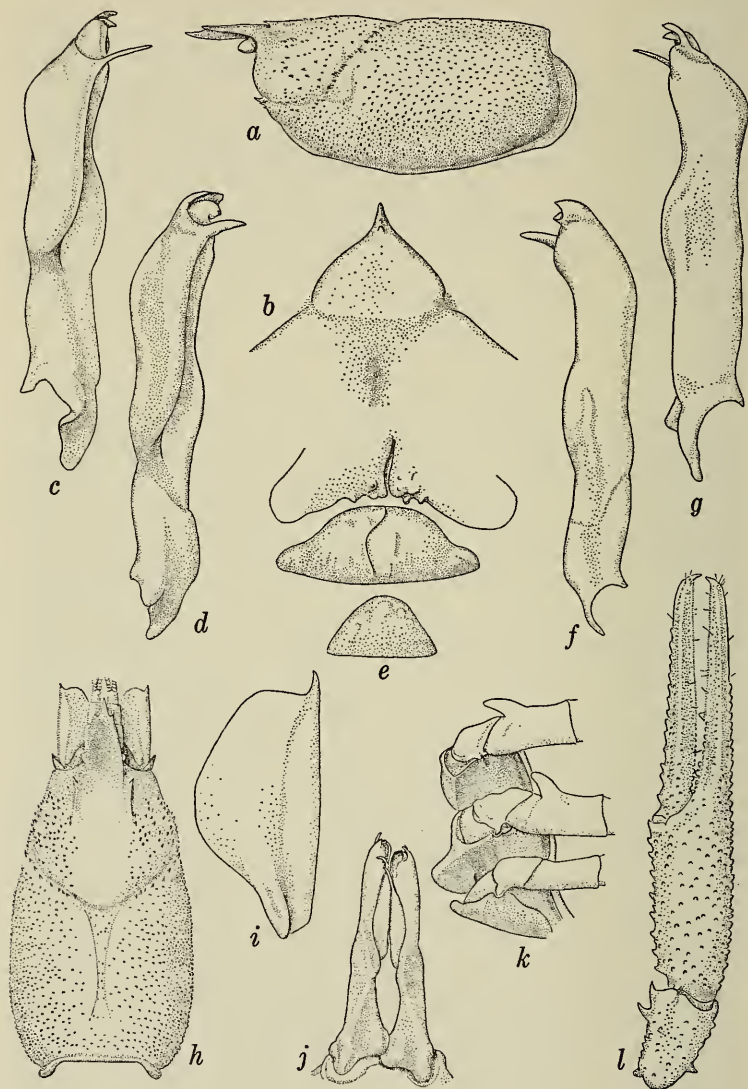


FIG. 2. *Procambarus horsti* new species. a, Lateral view of carapace of holotype; b, Epistome of holotype; c, Mesial view of first pleopod of holotype; d, Mesial view of first pleopod of morphotype; e, Annulus ventralis of allotype; f, Lateral view of first pleopod of morphotype; g, Lateral view of first pleopod of holotype; h, Dorsal view of carapace

as long as areola (length 41.8 percent of entire length of carapace). Rostrum excavate dorsally, with unthickened, moderately convergent margins; marginal spines acute, distinctly delimiting base of acumen, latter extending to midlength of ultimate segment of peduncle of antennule; upper surface with deepest concavity at level of caudal margin of orbit, with submarginal row of setiferous punctations and widely scattered ones between. Subrostral ridges weak and evident in dorsal aspect only in caudalmost orbital region. Postorbital ridges very prominent, distinctly grooved dorsolaterally, and bearing large, acute apical spines and 2 or 3 spiniform tubercles situated at caudal base of ridges. Suborbital angle very weak, and rounded. Branchiostegal spine strong, curved cephalodorsally, and 2 smaller spines situated immediately caudoventrally. Carapace with few punctations dorsally and in cephalic hepatic region, otherwise studded with crowded tubercles, most of those in hepatic region spiniform or subspiniform; cervical spine forming one of irregular series (approximately 18 on each side) extending along posterior margin of cervical groove from anterior extremity of branchiocardiac grooves anteroventrally to branchiostegal spine, 2 in usual position of cervical spine bi- or trispinose.

Abdomen and carapace subequal in length (34.5 and 34.2 mm). Cephalic section of telson with 4 spines in dextral and 3 in sinistral caudolateral corners. Cephalic portion of epistome subcordiform, with prominent cephalomedian projection bearing prominent tubercle ventrally near base; lateral margins not elevated; surface subplane; fovea represented by moderately deep longitudinal groove. Antennules of usual form, with longest (mesial) flagellum 1.6 times length of areola and with anterolaterally directed spine on ventral surface of basal article of peduncle near midlength. Antenna extending some distance caudal to margin of telson. Antennal scale (Fig. 2i) approximately 2.1 times longer than broad, its greatest width distinctly proximal to midlength, with lamellar area broader than thickened lateral portion; latter terminating in moderately long spine.

Third maxilliped surpassing apex of rostrum by length of dactyl and one-half that of propodus; opposable margin of ischium with teeth and with ventrolateral surface devoid of setae.

Right chela (Fig. 2l) slender and elongate, subovate in cross section, not strongly depressed. Mesial surface of palm with row of 9 tubercles subtended by other sublinear series above and below; lateral margin of palm with serrations extending slightly beyond midlength of fixed

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of holotype; i, Antennal scale of holotype; j, Caudal view of first pleopods of paratypic male, form I; k, Basal podomeres of third, fourth, and fifth pereopods of holotype; l, Dorsal view of distal podomeres of cheliped of holotype.

finger; dorsal and ventral surfaces entirely tuberculate. Fixed finger with submedian longitudinal ridges dorsally and ventrally, both ridges flanked by tubercles along basal two-fifths to one-half, and by setiferous punctations distally; opposable margin with row of 11 tubercles along proximal half, third and fourth from base largest, and more massive tubercle at lower level between ninth and tenth tubercles of upper row; crowded minute denticles present from base to corneous tip of finger. Dactyl with dorsal and ventral surfaces similar to those of fixed finger; mesial surface serrate to base of distal fourth; opposable margin with row of 12 small tubercles, second and fourth from base slightly larger than other members of row; crowded minute denticles distributed as on fixed finger.

Carpus of right cheliped longer than broad (7.5 and 4.0 mm) with all surfaces tuberculate; dorsal surface with only faint depression representing usual oblique longitudinal groove; dorsomesial margin with 2 prominent spines, 1 at distal angle and other slightly proximal to it; ventrodistal margin with 2 spines, 1 at base of ventrolateral condyle, other more mesial in position.

Merus of right cheliped tuberculate except proximomesially where sparsely punctate; upper surface with 5 spiniform tubercles, 4 of which grouped subdistally; ventral surface with 2 rows of 16 tubercles converging to strong spiniform tubercle at mesiodistal angle; other, generally smaller, tubercles between rows, and serially arranged ones mesially and laterally; ventral laterodistal angle also with strong spiniform tubercle. Ischium serrate dorsally, punctate laterally and mesially, and tuberculate ventrally; ventral surface with row of 5 tubercles flanked by additional smaller ones. Basis with single prominent tubercle ventrally, otherwise punctate.

Hooks on ischia of third and fourth pereopods (Fig. 2k) simple and overhanging corresponding basis; basis of fourth pereopod with small tubercle opposing hook. Coxa of fourth pereopod with prominent swollen boss; that of fifth pereopod with smaller cephalocaudally flattened prominence extending ventrally from ventral caudomesial angle.

Sternum between second, third, and fourth pereopods moderately deep and bearing heavy fringe of setae on ventrolateral margins.

First pleopods (Fig. 2c, g, j) as described in diagnosis. In addition, subterminal setae projecting caudodistally from cephalic base of vestigial caudal knob around cephalic side to level of midlength of mesial base of adventitious process.

Uropod with 2 distally projecting spines on basal podomere; median spine on mesial ramus not reaching distal margin of ramus.

Allotypic Female: Differing from holotype in following respects: rostrum with more convergent margins and tip of acumen reaching distal end of antennular peduncle; series of cervical spines resembling rather closely that of morphotype with single simple spine in location of usual cervical spine; cephalic section of telson with 2 spines in each caudolateral corner; mesial margin of palm of chela with 10 or 11 tubercles;

Table 2. Measurements (mm) of *Procambarus horsti*.

	Holotype	Allotype	Morphotype
Carapace:			
Height	14.1	15.0	15.2
Width	17.6	20.2	20.5
Length	34.2	39.0	38.7
Areola:			
Width	0.9	1.1	1.2
Length	14.3	15.7	16.2
Rostrum:			
Width	3.7	4.7	4.3
Length	8.0	9.1	9.0
Chela:			
Length of inner margin of palm	10.4	9.9	10.0
Width of palm	5.7	5.6	5.5
Length of outer margin of chela	27.8	29.0	32.6
Length of dactyl	16.5	17.2	20.4

serrations on lateral margin of chela and mesial margin of dactyl extending no farther than midlength of fingers; opposable margins of fixed finger and dactyl with 7 and 9 small tubercles, respectively; ventral surface of merus with 2 rows of 15 spines each; basis of dextral cheliped with very small tubercle, that of sinistral member lacking tubercle. See Table 2.

First pleopods uniramous and small but extending cephalad to cephalic margin of annulus. Sternum cephalic to annulus ventralis (Fig. 2e) with deep median fissure flanked caudally by pair of tubercles subtended laterally by 1 or 2 additional ones. Annulus broader than long, rounded cephalically, and with almost straight caudal margin; surface weakly sculptured but strongly convex ventrally, bearing shallow, slightly curved, longitudinal fissure sinistral to more prominent submedian sinus; sinus originating near median line on cephalic slope, curving gently caudodextrally and finally caudosinistrally, terminating before reaching midcaudal margin. Postannular plate subtrapezoidal in outline, elevated in cephalic half with 6 tuberculiform prominences, medianmost largest.

Morphotypic Male, Form II: Differing from holotype in following respects: apex of acumen almost reaching distal end of ultimate article of antennule; cervical spines and other spines in same series not so strongly developed, only 1 large, simple spine present in usual

position of cervical spine; cephalic section of telson with 2 spines in each caudolateral corner; mesial margin of palm of chela with tubercles more irregularly arranged, but spaced similarly to those in holotype; serrations on lateral surface of chela not quite reaching midlength of fixed finger; opposable margin of fixed finger with row of 13 small tubercles, that of dactyl with 18; caudalmost tubercle on dorsomesial distal portion of merus of cheliped much reduced in size; approximately 20 tubercles in lateral and 23 in mesial row on ventral surface of merus of cheliped, and 7 on ischium; basis of cheliped lacking ventral tubercle; hooks of ischia of third and fourth pereopods greatly reduced in size; sternum between posterior 3 pairs of pereopods with much shorter setae. See Table 2.

First pleopods (Fig. 2d, f) symmetrical and with oblique suture near base. Terminal elements noncorneous, proportionately more massive, except for caudal element; latter much reduced in size. Cephalic process considerably larger and hooding smaller central projection.

Type-locality: Big Blue Springs (tributary to the Wacissa River), 2.2 miles south of the crossroads in the town of Wacissa, Jefferson County, Florida (SE $\frac{1}{4}$, NW $\frac{1}{4}$, Sec. 12, T. 2S, R. 3E). In describing the type-locality, Mr. Horst wrote the following: "Our next stop was Big Blue Springs, which is much like a huge bowl filled with crystal clear water: 25 yards across and about 50 feet deep at the center. The boil . . . is at the very bottom and is about four feet in diameter. With underwater lights and safety lines, we entered the cave source going straight down, pulling ourselves in, as the water exiting the spring source has a great deal of force. The hard limestone bottleneck which we had entered was about ten feet in length and opened into a small room which contained several branches. . . . The floor of this room was white with crayfish: a huge population. . . . In spite of the direct beams of our diving lights, the crayfish exhibited no variation in behavior. They extend throughout the entire spring, at least as far as we have been able to go with our diving gear, maximum depth being 70-80 feet. I saw little in the way of food, aside from many intact gastropod shells. . . . In collecting the specimens, we encountered two individuals with some brown hue to their carapace. . . . Also, we noted in collecting the crayfish in the cave that they seem quite weak. . . . In general, they are inactive during the day and extremely active at night. . . . I found two or three specimens in protected areas of the 'bowl', completely out of the cave itself, but near auxiliary entrances." In investigating other springs of the Wacissa, Mr. Horst found no other crayfish populations.

Types: The holotypic male, form I, allotypic female, and morphotypic male, form II, (Nos. 132043, 132044, 132045, respectively) are deposited together with the paratypes (2 ♂ I, 2 ♀) in the National Museum of Natural History, Smithsonian Institution. All specimens were collected by Michael N. Horst in October 1970.

Size: The largest first form male has a carapace length of 41.1 mm,

the smallest, 32.5 mm. The allotype has a comparable length of 39.0 mm and a paratypic female, approximately 40.6 mm (the rostrum is injured).

Range: Although positively known only from the type-locality, a single male collected from a "well-digging rig" on the farm of Mr. Pichard, 4.5 miles east of Tallahassee on the Old St. Augustine Road, is tentatively assigned to this species.

Variations: While variations in minor features are rampant in this species, rather slight differences occur in most of the characters singled out in the above descriptions. Among these are the following: the apex of the rostrum reaches at least to midlength of the ultimate article of the antennular peduncle, and never extends beyond it for a distance of more than a fraction of a millimeter; the posterior spiniform tubercles at the posterior extremity of the postorbital ridges vary in number from 2 to 5, occasionally long and slender but more often only slightly more conspicuous than the adjacent tubercles on the hepatic region; small tubercles are sometimes present both in the posterior gastric and posterior cardiac regions of the carapace; the epistome is occasionally subtrapezoidal in shape with faintly elevated (ventrally) cephalolateral margins; the number of spines in the cervical series varies from 10 to 18, and they may range in size from scarcely larger than the adjacent branchiostegal tubercles to 3 or 4 times as large, most of them with strongly acute tips; the number of tubercles in the row along the mesial margin of the palm of the chela varies from 8 to 10; the upper surface of the merus of the cheliped exhibits considerable variation in development of tubercles and spines: in some chelipeds they increase in size progressively distally; in others such a gradation is hardly evident, with the largest members in the distal group and 1 or 2 others projecting well above their immediate neighbors; the ventral surface of the merus may have as many as 20 tubercles comprising the 2 rows. In the largest first form male, the basal tubercle opposing the hook on the ischium of the fourth pereopod is much more massive than that in the holotype. In one of the paratypic females, the sinus of the annulus ventralis is C-shaped, the sinistral fissure is much broader and deeper than in the allotype, and there are 1 or 2 small tubercles situated near the lateral margins; the postannular plate bears 8 conspicuous tubercles. Other differences have been pointed out in the comments on the allotype and morphotype.

The single male collected on the Pichard Farm has a carapace length of 17.7 mm, is comparatively less spiny than are the members of the type-series. The marginal spines of the rostrum and the apical spine on the postorbital ridges are very short. Cervical spines are lacking but are represented by 1 or 2 minute tubercles; otherwise the carapace is smooth. The areola constitutes only 37.8 percent of the total length of the carapace; however, inasmuch as we have no specimens of comparable size from the population in the type-locality, it is possible

that smaller specimens have a proportionately shorter areola, suggestive of the variations noted in *Procambarus orcinus*.

Etymology: This species is named in honor of Michael N. Horst who kindly donated to us the series of specimens on which this description is based.

Relationships: *Procambarus horsti* and *P. orcinus* are distinctly more closely related than either is to *Procambarus pallidus*, their closest previously described ally. The obvious similarities between the three lie in the conspicuous major morphological features and in details of the secondary sexual characteristics. All three are exceedingly tuberculate; the cephalothorax is inflated; the chelipeds are long and slender; the rostral margins are convergent; simple hooks are present on the ischia of the third and fourth pairs of pereopods; and the humped form of the first pleopod and the comparative sizes of the terminal elements are noteworthy. In the female, the sternum immediately cephalic to the annulus ventralis is cleft and tuberculate, and the similar conformation of the annulus is striking. The features which set *P. pallidus* apart from the two described here, while seemingly minor in character, are constant. Most conspicuous among them is the absence of posterior spines on the postorbital ridges, the absence of spiniform development of the tubercles in the hepatic and cervical regions, and usually the reduction of the marginal spines, often represented by tubercles, on the rostrum. In the pleopod of the first form male, the cephalic process is situated cephalolateral to the central projection and partially hoods it, whereas in the other two species it is distinctly lateral in position, compressed laterally, and in no way overhangs the central projection.

Procambarus horsti differs from *P. orcinus* in lacking pigmentation of any kind either in the eye or body musculature, although in living individuals, the yellow hepatopancreas and brown ovary may be seen through the integument; the areola is narrower (13.5 to 19.2 times longer than broad as opposed to 8.9 to 11.8 in *P. orcinus*) and longer, constituting 40.2 to 41.8 percent of the total length of the carapace (31.2 to 35.6 percent in *P. orcinus*). It is much more strongly tuberculate, but the spiniform tubercles and spines are not nearly so well developed as in *P. orcinus*. The pleopods, although markedly similar to those of the latter, have a much less well-developed caudal knob.

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